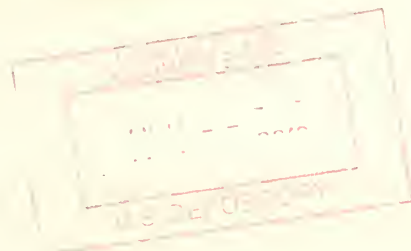


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PROPER NAILING OF CAR BRACING

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PROPER NAILING OF CAR BRACING

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The ease with which wood can be cut, fitted, and fastened, in addition to its light weight and availability, has made it an efficient and practical material for car bracing. Yet the very ease and simplicity of using wood often causes some of the basic principles of nailing to be overlooked, with the result that the bracing may not measure up to its full possibilities for strength and effectiveness.

The nailing of car bracing frequently requires the exercise of judgment as to best practice, especially when in some particular instance it is impossible to meet ideal conditions. For example, what is the best detail for nailing a 2-inch cleat to the 2-inch car floor when it is known that, in general, the penetration in the piece receiving the point of the nail should be at least twice that through which the nail passes? Again, is there any advantage in having the nail pass entirely through both pieces being joined?

Before discussing nailing in detail, it is well to recount the several ways nails may be called on to function. Nails may be subjected to direct withdrawal, to lateral displacement, or to a combination of both. Resistance to withdrawal, as the name implies, is the reaction to forces tending to pull the nail out in the direction of its length, whereas, lateral resistance is the reaction to forces tending to bend the nail or push it sidewise.

It is known that resistance to withdrawal is related to the density or hardness of the wood. The dense woods hold nails much better than do the light weight woods. In fact, resistance to direct withdrawal (as opposed to lateral resistance) varies about as the second power of the specific gravity of the wood. This does not imply that light or low density species are not entirely suitable for car bracing. To get the same nail strength with the softer woods, however, requires more, larger, or improved nails. The resistance to withdrawal also depends on the area of contact of the nail with the wood, and hence increases directly with the diameter of nail and with depth of penetration as long as no splitting of the wood occurs.

Lateral resistance for a nail of given size increases with the density of the wood, but not quite so rapidly. It also increases about as the $3/2$ power of the nail diameter. Thus, the safe lateral load for a 20d nail in white pine is nearly twice that on an 8d. For white oak the ratio is about the same but, because of its higher density, the loads are about 50 percent higher than for the pine.

Some Important Details in Car Bracing

To obtain good nailing the following general details should be observed:

Use nails of proper length. Wherever possible the nails should be long enough so that in softwoods approximately two-thirds of the length goes into the member receiving the point. This means that the length of the nail should be at least three times the thickness of the outer piece (fig. 1). Where the thickness of the members does not permit this suggested depth of penetration a sufficient number of shorter nails should be used to provide equivalent area of contact in the wood member receiving the point.

Drive nails so that the points do not come out of the side of the piece. These "shiners" as they are called not only result in weakened joints but are also a cause of injury.

Be sure the nails you use do not split the wood. Splitting greatly weakens the joint. If the wood tends to split badly use a thinner nail, blunt the points, or, better still, purchase nonsplitting nails. When practical, boring lead holes slightly smaller in diameter than the diameter of the shank of the nail is excellent practice.

Use plenty of nails. The strength increases directly as the number of nails used.

Whenever possible, do not use nails in direct tension, but use them preferably in lateral resistance. When nails in direct tension give way they usually fail suddenly and may cause injury or damage. The resistance to withdrawal is influenced greatly by the surface condition of the nail. For temporary service, cement-coated nails may be expected materially to increase the holding power but a more permanent and greater increase may be obtained with special nails having a minutely pitted or etched surface.

Do not expect good nailed joints when using green wood that will later dry out. Nails driven in green wood that later dries out quite commonly lose most of their holding power. Hence, use dry lumber.

Resistance to Lateral Stress

Nails are more efficient when driven into side grain of dry wood than when driven into the end grain.

The lateral resistance of nails is expressed by the formula $P = Kd^{3/2}$

Where P represents the ultimate load on the nail in pounds; K represents a constant depending on the species of wood (oak 8,500, northern white pine 4,500, southern yellow pine 7,000), and d represents the diameter of the nail in inches.

The accompanying table based on this formula gives recommended values of safe lateral resistance, expressed in pounds per nail, for common wire nails, driven perpendicular to the grain of wood at 15 percent moisture.

The bracing material should be free of knots and cross grain at the places where it is to be nailed. Wood splits easily when nailed near a knot or when cross-grained at the nailing ends, with the result that the effectiveness of the nailing is either seriously impaired or perhaps entirely lost.

Table 1.--Safe lateral resistance¹ of nails

<u>Species</u>	<u>Pounds per nail size of</u>								
	4d	6d	8d	10d	12d	16d	20d	30d	40d
Northern white pine, ponderosa pine, and spruce ..	28	34	43	51	51	59	76	85	96
Southern yellow pine, Douglas-fir, and western larch	43	52	65	78	78	90	116	130	147
Oak, sugar maple, birch, beech, and ash.....	53	65	81	97	97	111	143	160	181

¹These safe loads are recommended for permanent nailed construction, and consequently for temporary nailing such as in car bracing, higher values may be used. When ultimate loads are required for design, they may be conservatively considered as five times the safe loads given in the table. The actual ultimates are from six to eleven times the safe loads.

Some Special Problems in Car Bracing

Let us consider some of the special problems of bracing carload shipments, assuming nominal 2 by 4 inch to 2 by 10 inch bracing lumber, sheathing, or car lining ranging from 1-1/4 to 1-3/4 inches, and car floors 1-1/4 to 2-1/2 inches thick.

Nail Sizes.--What size of nail should be used? First, we must select a size and type of point that does not split the wood, and when used with sheathing or flooring, a length sufficient to completely penetrate the piece holding the point. With stanchions and very thick material two-thirds of the length should be in the member holding the point. With these conditions fulfilled, the size of nail makes little difference as long as the same total weight of nails is used and provided the nails do not bend in driving. The slight advantage in this instance is in favor of the smaller diameter nail used in greater quantity.

Nails Penetrating Through Members.--When nails penetrate through a piece of wood they frequently tear off a sliver when the point emerges. Highest resistance to withdrawal results with nails just short enough so that they do not come through the member receiving the point. On the other hand, the shock, or repetition of shock required to tear the bracing entirely off is greatest for a long nail that protrudes some distance through the piece.

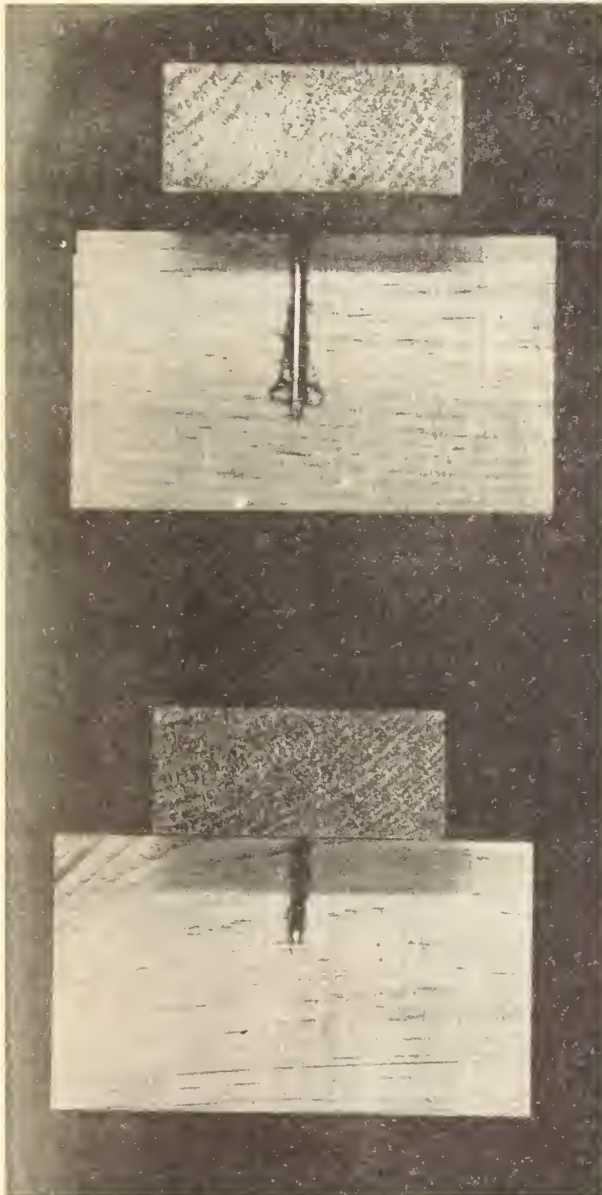


Figure 1—Nail joint sawed open to expose lengths of nail. Above: Good practice. Nail of proper length, about two-thirds of the length being in the block receiving the point. Below: Poor practice. Nail too short, giving insufficient length in block.

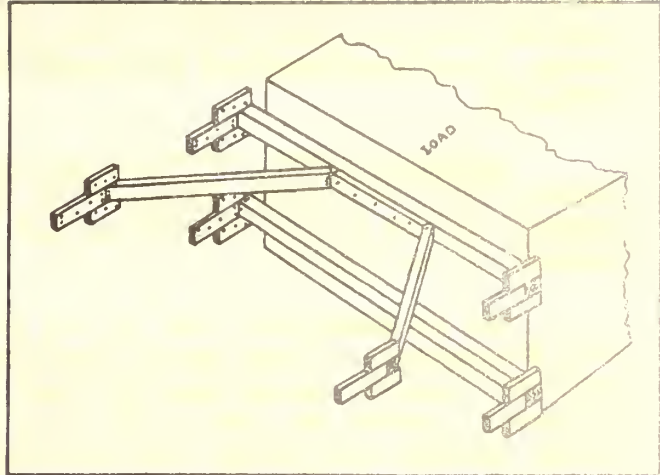


Figure 2—Diagrammatic sketch of "K" brace commonly used in car shipment.

Direction of Nail.--Slant driving of nails does not give any advantage over straight driving. In fact, when the points do not pass entirely through all members, the straight driving is preferable because a greater portion of the length will be in the place receiving the points. When the nail extends through the member receiving the point but little difference is evident.

Position of Cleat.--It is important to place wall cleats so that the nails go into the stanchions rather than into the sheathing or siding alone. A nail may then be chosen which will more nearly meet the desired condition of having about two-thirds of its length in the members to which the cleat is fastened.

Number of Nails.--A dry 2 by 6 placed with its edge against a load will require three to six 20d nails in the cleat at each end to develop the full strength of the 2 by 6, depending upon the arrangement of the cleat and the quality of the 2 by 6.

Let us assume that one of the diagonals of a K brace (fig. 2) is a 2 by 6 of Douglas-fir, 6 feet long. This brace acts as a long column and the crippling load it should take is about 6,000 pounds. Part of the load is taken by thrust against the side of the car, part by friction, and the balance by thrust against the cleats. If it is estimated that 3,000 pounds of the total thrust is taken by the cleat, and that the ultimate lateral resistance load for a 20d nail is 580 pounds (safe load 116×5), it is evident that at least five 20d nails should be used to develop the strength of the car brace. If this brace were only 4 feet long, and of good grade and quality of material, double the above number of nails in the cleat would be required to hold it.

Quality of the Wood.--The effective nailing scheme to fit any problem in car bracing cannot be applied if the lumber to be used consists of indiscriminately mixed species and mixed grades. However, the use of mixed material is not objectionable provided it is first segregated into groups of species having the same nailing properties. Furthermore, if low-grade material is otherwise permissible, none of the defects, as previously pointed out, should be allowed at the point of nailing.

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